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Short Communication

Physicochemical properties of Aus cultivars in Bangladesh.

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ABSTRACT: A total of 17 Aus rice cultivars including 10 (ten) local cultivars like Surjamukhi, Burikatari, Sada Dumra, Chakilla, Agaua, Bir Madla, Panki Raj, Tubri, Phul Dumra, Kasalath and 7 (seven) modern HYV rice varieties like BR20, BR21, BR24, BR26, BRRI dhan42, BRRI dhan43, BRRI dhan48 were studied for a comparative study on physicochemical and cooking properties. The highest milling outturn 72.22% was found in the traditional variety Chakilla and lowest in Kasalath (65.43%). The highest milled rice length (6.5 mm) was BRRI dhan42 and the highest length-breadth ratio (3.8) was found in both BR24 and BR26. The lowest grain length was found in BR20 (5.0 mm) and lowest length-breadth ratio were found in Phul Dumra (2.0). Apparent Amylose content (AAC) of these cultivars range from 22.0% (Surjamukhi) to 27.0% (BR24, BRRI dhan43 and BRRI dhan48). All the varieties contain more than 7.6% of protein. Traditional Aus cultivars possess more protein content than BRRI varieties. Maximum cooking time (23:30 mins.) were required for Phul Dumra and minimum (15:30 mins) for BR21 rice. Elongation ratio (ER) of grains of local and modern Aus rice cultivars varied between 1.1 to 1.2 and 1.3 to 1.6 respectively. The highest imbibition ratio (IR) of 4.4 was found in BRRI dhan43. Among all studied cultivars, Surjamukhi has aroma and it has yellowish grain color with red pericarp. Chakilla has black grain color with red pericarp and rest of the traditional cultivars have white grain color and red pericarp. Modern HYV rices have white grain color and white pericarp.

KEYWORDS: Rice Varieties, Milling outturn, Apparent Amylose Content (AAC), Protein, High yielding varieties (HYV)

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INTRODUCTION

The Aus rice is actually pronounced Aoosh, which is derived from (the Bangla word) Ashoo meaning “early”; so earliness is the main character of Aus rice varieties (Sophie, 2012). It is a pre-monsoon rice growing season where farmers grew short maturity drought tolerant rice varieties by direct seeding under rainfed conditions. The traditional Aus varieties are very low-yielding with a maximum yield of 1.5 to 2.0 t/ha. Over time with the expansion of irrigation facilities the Aus varieties have given way to Boro varieties, because the later gives two to three times higher yield than the former. The area under Aus rice has declined from over 3.0 million ha in the 1960s, to less than 1.0 million ha by mid 2000s (Hossain, 2013). The biodiversity is the highest in the Aus season. It is also noted that most of the Aus high-yielding varieties are released for the Boro season. These varieties take longer time to mature in the Boro season because of dormancy during the cold temperature. They mature earlier in the Aus season because of high temperature. But the yield is almost 1.5 t/ha less, because of water stress under rainfed growing conditions and higher weed and pest pressure. The yield of the popular traditional Aus varieties are 2.03 t/ha for Haitta, 2.12 t/ha for Kali boro, 2.05 t/ha for Muralee, 1.87 t/ha for Hashi Kalmi, and 2.43 t/ha for Binni Dhan (Hossain, 2013). The discovery of the *PSTOL1* gene from Kasalath Aus variety rice mainly grown in Shylet region of Bangladesh and part of India which has potential to improve the food security of rice farmers with the lowest value phosphorus-deficient land. The Aus group of rice are known to carry genes for tolerance to drought, heat, salinity and already became popular source of important genes like *Sub1* and *PSTOL1* to submergence tolerant and Phosphate deficiency tolerance respectively (Sophie, 2012).

Rice is the staple dietary item for the people and per capita rice consumption is about 166 kg year^{-1} (BBS, 2010). Rice alone provides 76% of the calorie intake and 66% of total protein requirement (Bhuiyan et al., 2002). Since Bangladesh has sufficient rice production which will enable to provide local demand and emergency storage, So, it’s high time to focus on grain quality and nutrition of rice to meet the demand of different income class people in home and abroad. Thus physicochemical properties of local fine rice has extra value in a way to improve our HYV rice through cooperation of local germplasm specially Aus. Grain quality is a combination of physical as well as chemical properties of rice which seems very important for consumer's preference. Quality characteristics of rice are related to complex physicochemical properties (Juliano 1972). Rice quality is mostly determined by its chemical, physical, cooking and eating characteristics (Cameron et al, 2007). There are thousands of rice cultivars are grown in Bangladesh but information on their grain quality is

limited. Biswas et al, (1992) studied the quality of some modern and local improved rice. Yields of head rice vary depending on the factors such as variety, grain type, chalkiness, cultural practice, dying, storing and milling conditions (Wasserman and calderwood, 1972, Witte, 1972, Adair et al, 1973). Size and shape are also important factor to consumer. Preference for rice grain size and shape vary from one group of consumers to another (Khush et al, 1979). High income group of people in Bangladesh prefer long slender grain, whereas lower income group prefer bold grain. Starch, a major component of rice is composed of individual granules which consist mainly of two glucose homopolymers: amylose and amylopectin. Amylose is essentially a linear polymer, whereas amylopectin molecules are highly branched and together they have been shown to affect the properties of starch (Goddard et al., 1984, & Morvarid et al., 1998). Apparent Amylose content (AAC) of rice is consider as the main parameter of cooking and eating quality (Juliano, 1972). A varying amylose content of 20-33% is found in rice starch and classified as waxy (0-2%), very low (2-12%), low (12-20%), intermediate (20-25%) and high (25-33%) (Juliano 1972). AAC alone influences many of the starch properties. AAC, volume expansion, water absorption influences many of the starch properties of rice (Juliano, 1979). Cooking behavior is one of the important determinants of quality (Feillet and Marie 1979). Cooking time is important as it determines tenderness of cooked rice as well as stickiness to great extent. Higher the imbibitions ratio (IR) of rice lower will be the energy content per unit volume or weight of cooked rice, as they will have more water and solid materials. High volume expansion of cooking is still considered to be the good quality by the working class people who do not care whether the expansion is length wise or crosswise. Urban people, on the other hand, prefer the varieties that expand more in length than in breadth (Choudury, 1979).

Since Aus rice group has shorter duration and capabilities to address biotic and abiotic physiologically stress condition, so this particular group is being drawn attention to rice scientist for extensive research activities. There is very limited information on the above comparative study on physicochemical properties of these selected HYV and local Aus cultivars. These cultivars are being grown in the country and may have some useful characteristics, which would be helpful for developing improved new rice varieties. Therefore the present study was undertaken to determine the physicochemical properties and characteristics of grain and cooked rice.

MATERIAL AND METHODS

A total of 17 (seventeen) Aus rice cultivars including 10 (ten) local traditional varieties Like Surjamukhi, Burikatari, Sada Dumra, Chakilla, Agaua, Bir Madla, Panki Raj, Tubri, Phul Dumra, Kasalath and 7 (seven) modern HYV rice varieties like BR20, BR21, BR24, BR26, BRRI dhan42, BRRI dhan43, BRRI dhan48 were collected from GRS (Genetic Resource and Seed) division of BRRI (Bangladesh Rice Research Institute) Gazipur. The samples were milled unparboiled and analysed for physicochemical properties. Milled rice outturn was determined by dehulling 200g rough rice in Satake Rice Mill, followed by 45 second polishing in a satake Grain Testing Mill TM-5. Slide Calipers was used for the measurement of grain length and breadth. Milled rice was first classified into three classes based on length, long (>6.0 mm in length), medium (5-6 mm in length) and short (<5.0 mm in length). They were again classified into three classes according to the length/breadth (L/B) ratio; slender (ratio more than 3.0); Bold (ratio 2.0-3.0) bold, Round (ratio<2.0) to determine size and shape. Amylose content was determined by the procedure of Juliano (1971) and alkali spreading value was determined according to the procedure of Little et al., 1958. Protein contents were calculated from nitrogen and was determined by Micro Kjeldahl method. Volumes of cooked and milled rice were measured by water displacement method. Five gram of milled rice was placed in a graduated cylinder containing 50 mL of water and the change in volume was noted. For cooked rice volume 5 g of milled rice was cooked and the cooked rice was placed in the same cylinder and the change in volume was measured. Cooking time was measured when 90% of cooked rice totally gelatinized. Duncan's multiple range test (DMRT) was applied on AAC %, Protein content (%) and ASV parameter for statistical analysis using SPSS, version 20.0.

RESULTS AND DISCUSSION

Rice grain quality is based on appearance, size and shape of the grains, behavior upon cooking, taste, tenderness and flavor of cooked rice (Juliano et al, 1964). Translucent grain with little or no white belly, intermediate gel consistency, intermediate amylose content and low starch content are the desired attributes of good quality rice (Khush et al, 1979). In this study, the highest milling outturn 72.22% was found in the traditional variety Chakilla and lowest in Kasalath (65.43%). Grain length and L/B ratio of the cultivers range from 5.2 mm to 6.5 mm and 2.0 to 3.8 respectively. The highest milled rice length (6.5 mm) was BRRI dhan42 and the highest length-breadth ratio (3.8) was found in both BR24 and BR26. The lowest grain length was found in BR20 (5.0 mm) and lowest length-breadth ratio were found in Phul Dumra (2.0). Among all studied cultivars, Surjamukhi has aroma and it has yellowish grain color with red pericarp. Chakilla has black grain color with red pericarp and rest of the traditional cultivars have white grain color and red pericarp. Modern HYV rices have white grain color and white pericarp. All cultivars are translucent and looked good in appearance. Traditional Aus rices are medium in size and bold in shape (Table 1).

In analysis of chemical properties we analyzed AAC%, Protein content (%) and ASV parameters for seventeen rice varieties. AAC of the rice starch is the major eating quality factor. It has influence on volume expansion, water absorption, tenderness and stickiness of cooked rice. Amylose content of rice determines the hardness and stickiness of cooked rice. Amylose content higher than 25% gives non sticky soft or hard cooked rice. Rice having 20-25% amylose gives soft, and relatively sticky cooked rice. Apparent Amylose content (AAC) of these cultivars range from 22.0 (Surjamukhi) to 27.0 (BR24, BRRI dhan43 and BRRI dhan48).

Table 1: Physical properties of Traditional and HYV Aus rice cultivars in Bangladesh.

Variety	Milling outturn%	Chalkiness	Awn	Paddy Color	Pericarp Color	Aroma	Length (L) mm	L/B ratio	Size & Shape
Surjamukhi	66.47	Tr	No	Yellowish	Red	Yes	5.3	2.4	MB
Burikatari	70.79	Tr	No	Radish	Red	No	5.2	2.1	MB
Sada Dumra	70.00	Tr	No	White	Red	No	5.5	2.2	MB
Chakilla	72.22	Tr	Yes	Black	Red	No	5.4	2.1	MB
Agaua	69.67	Tr	No	White	Red	No	5.2	2.3	MB
Bir Madla	70.75	Tr	No	White	Red	No	5.6	2.2	MB
Panki Raj	67.25	Tr	No	Radish	Red	No	5.5	2.2	MB
Tubri	69.63	Tr	No	White	Red	No	5.5	2.2	MB
Phul Dumra	67.93	Tr	No	White	Red	No	5.4	2	MB
Kasalath	65.43	Tr	Yes	White	Red	No	5.1	2.4	MB
BR20	71.00	Tr	No	White	Red	No	5.0	2.3	MB
BR21	71.00	Tr	No	White	Red	No	5.1	2.6	MB
BR24	70.00	Tr	No	White	Red	No	6.0	3.8	LS
BR26	68.00	Tr	No	White	Red	No	6.0	3.8	LS
BRRI dhan42	71.00	Tr	No	White	Red	No	6.5	3.1	LS
BRRI dhan43	69.00	Tr	No	White	Red	No	5.8	2.4	MB
BRRI dhan48	72.00	Tr	No	White	Red	No	6.0	2.6	MB
Medium (M); Bold (B);Long (L); Slender(S); Translucence (Tr);Bangladesh Rice Research Institute released dhan (BRRI dhan).									

ASV (Alkaline Spreading Value) had inverse relationship with GT (Gelatinization Temperature). Alkali spreading value of the tested varieties ranges from 3.2 to 4.9. The highest ASV (4.9) and lowest ASV (3.2) was found in local variety Kasalath and Panki Raj respectively. Protein content of rice is important from nutritional point of view. Several factors such as variety, environmental and cultural practices may influence the protein content of the grain. All the varieties contain more than 7.6% of protein (Table 2). Traditional Aus cultivars possess more protein content than BRRI varieties. Protein content of the tested varieties range from 7.6 % to 10.5%. The highest protein content was found in Phul Dumra (10.5%) and the lowest protein content was found in BRRI dhan43 (7.6%).

Gelatinization temperature (GT) of all tested traditional varieties have high GT value accept Chakilla and Kasalath (intermediate). Majority of HYV rices have intermediate GT. Cooking time of the rice grain depends on coarseness of the grain and its gelatinization temperature. It determines the tenderness of cooked rice as well as stickiness to some extent. Maximum cooking time (23:30 mins.) were required for Phul Dumra and minimum (15:30 mins) for BR21 rice. Elongation ratio is an important parameter for cooked rice. If rice elongates more lengthwise it gives a finer appearance and if expands breath wise, it gives a coarse look. Elongation ratio (ER) of grains of local and modern Aus rice cultivars varied between 1.1 to 1.2 and 1.3 to 1.6 respectively. Among the varieties the highest and the lowest elongation ratio of the tested varieties were BRRI dhan43 (1.6) and Panki Raj (1.1) respectively (Table 3).

However, higher to imbibition ratio of rice, lower will be the energy content per unit volume or weight of cooked rice as they will have more water and less solid materials. IR of grains of local and modern Aus rice cultivars varied between 2.4 to 4.4. The highest imbibition ratio (IR) of 4.4 was found in BRRI dhan43 and the lowest imbibition ratio (IR) of 2.4 was found in Panki Raj (2.4).

Table 2: Chemical Properties of Traditional and HYV Aus rice cultivars in Bangladesh.

Rice variety	Variety/Line	Protein %	AAC %	ASV
Traditional Rice	Surjamukhi	10.13± 0.25^{a}	22.03 ± 1.01^{g}	3.5 ± 0.1^{ef}
	Burikatari	9.6± 0.1^{b}	25.3 ± 0.61^{cde}	3.53 ± 0.07^{e}
	Sada Dumra	10.2± 0.2^{a}	23.36 ± 0.78^{f}	3.53 ± 0.05^{e}
	Chakilla	9.23 ± 0.35^{c}	25.6 ± 0.53^{cde}	4.1 ± 0.01^{cd}
	Agaua	8.93 ±0.20^{cde}	25.13 ± 1.01^{de}	3.46 ± 0.15^{ef}
	Bir Madla	8.76±0.25 ^{def}	25.16 ± 0.31^{cde}	3.53 ± 0.15^{e}
	Panki Raj	10.33 ±0.25^{a}	26 ± 0.34^{abcd}	3.23 ± 0.25^{f}
	Tubri	10.15 ± 0.18^{a}	25.8 ± 0.72^{bcde}	3.5 ± 0.2^{ef}
	Phul Dumra	10.5 ± 0.1a	24.6 ± 1.51^{e}	3.68 ± 0.02^{e}
	Kasalath	9.7 ± 0.2^{b}	24.53 ± 0.51^{e}	4.86 ± 0.15^{a}
BRRI Variety	BR20	8.66 ± 0.15^{ef}	25 ± 0.2^{de}	3.63 ± 0.15^{e}
	BR21	9.03 ±0.25^{cde}	24.66 ± 0.41^{de}	4.33 ± 0.25^{bc}
	BR24	9.09 ± 0.16^{cd}	26.46 ± 0.26^{abc}	4.06 ± 0.20^{cd}
	BR26	8.76 ±0.25 ^{def}	22.9 ± 0.26^{fg}	3.63 ± 0.15^{e}
	BRRI dhan 42	8.46 ±0.15^{fg}	25.83 ± 0.76^{bcde}	3.93 ± 0.05^{d}
	BRRI dhan 43	7.56 ±0.05^{h}	27.06 ± 0.41^{ab}	4.2 ± 0.1^{cd}
	BRRI dhan 48	8.21 ±0.12^{g}	27.16 ± 0.65^{a}	4.5 ± 0.1^{b}

Within column means followed by same letter (s) did not differ significantly at P<0.05.

Table 3: Cooking properties of Traditional and HYV Aus rice cultivars in Bangladesh.

Variety	GT	CT Mins	ER	IR
Surjamukhi	High	19:00	1.2	3.0
Burikatari	High	20:00	1.2	2.7
Sada Dumra	High	22:30	1.2	3.0
Chakilla	Intermediate	22:00	1.2	2.7
Agaua	High	21:30	1.2	3.0
Bir Madla	High	20:00	1.2	3.0
Panki Raj	High	23:00	1.1	2.4
Tubri	High	20:30	1.2	3.2
Phul Dumra	High	23:30	1.2	3.0
Kasalath	Intermediate	18:30	1.2	3.2
BR20	High	19:00	1.5	3.5
BR21	Intermediate	15:30	1.4	3.4
BR24	Intermediate	18:30	1.3	4.0
BR26	High	19:00	1.3	4.1
BRRI dhan42	High	18:30	1.4	4.2
BRRI dhan43	Intermediate	15:30	1.6	4.4
BRRI dhan48	Intermediate	18:30	1.4	3.4
Gelatinization Temperature (GT); Elongation Ratio (ER); Imbibition Ratio (IR); Cooking Time (CT mins)				

CONCLUSION

Fine rice in Bangladesh are low yielding and cannot compete with high yielding varieties (HYV) of rice. Rice production technologies regarding HYV are now well developed and adopted by farmers in Bangladesh for maximum production. It is now time to emphasize to the improvement of the productivity of fine rice including its quality. It is urgently needed to characterize the fine rice as regard to their physicochemical properties. Thus, the knowledge may be utilized for devising breeding strategy to their improvements for yield keeping intact their physicochemical qualities. Among traditional Aus varieties, Surjamukhi and Kasalath have desired attributes of good quality rice like good appearance, translucent grain, higher ER ratio, lower cooking time, and intermediate amylose content, high to intermediate gelatinization temperature (GT). In addition, Surjamukhi has aroma. These local Aus variety could be a useful germplasm in breeding program to get improve HYV specially for Aus season.

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